

# Influence of ultrasonic burnishing on the durability of the burnisher

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**Abstract.** The group of surface plastic deformation technologies includes a well-known burnishing technology. Adding the effects of ultrasonic vibrations to the process allows to obtain a certain topography of surface. However, the process of interaction between the tool and the part during processing redistributes the occurrence of wear centres on the tool's surface. The article also describes the effect of cavitation of lubricoolant agents on the resulting defects on the tool's surface. It was concluded that it is necessary to use an impact-resistant material for processing by ultrasonic burnishing technology.

## 1. Introduction

One of priority tasks of modern machine building industry is to improve the quality of the surfaces of processed products [1]. This problem becomes more actual because of the creation of new combined machining technologies when along with mechanical processing also there is a concentrated flux of additional energy, for example, the energy of the ultrasonic field, which is introduced into the surface layer of the workpiece. Recently, one of the most promising methods for finishing processing of machine parts are technologies without removing chips - methods of surface plastic deformation [2-5]. At present time, the effectiveness of using ultrasonic technologies in order to provide specified quality parameters for processing machine parts has been theoretically substantiated and practically proven. However, up to the present time the issues of instrumental support of ultrasonic burnishing technology have not been fully resolved. In the literature, there is practically no information on stability tests of various types of instruments operating in an ultrasonic field, and also there are no practical recommendations for the rational instrumental support of the ultrasonic burnishing technology.

Thus, increasing the effectiveness of ultrasonic burnishing technology by developing a system of rational instrumental support is actual scientific task.

## 2. Method and results of experimental research

At present, the domestic industry has commercialized the production of burnishing tools mainly from natural and synthetic diamonds. For instance, VNIILMAZ, located in Moscow, produces tips for diamond burnishing made of synthetic diamonds (ASPC) type "Carbonado" according to TU 2-037-100-89 and tips made of natural diamonds of type 1 with spherical and cylindrical working part according to TU 2-037-631-88. JSC "Moscow Production Association of diamond tools production" has



been created on the basis of the Tomilinsky diamond tools plant, and now manufactures burnishing tips with a working part made of natural diamonds and synthetic diamonds, such as "Carbonado" [6, 7]. These instruments can be used in ultrasonic technological equipment for burnishing. Also, there are other variants of tools embodiment for ultrasonic processing.

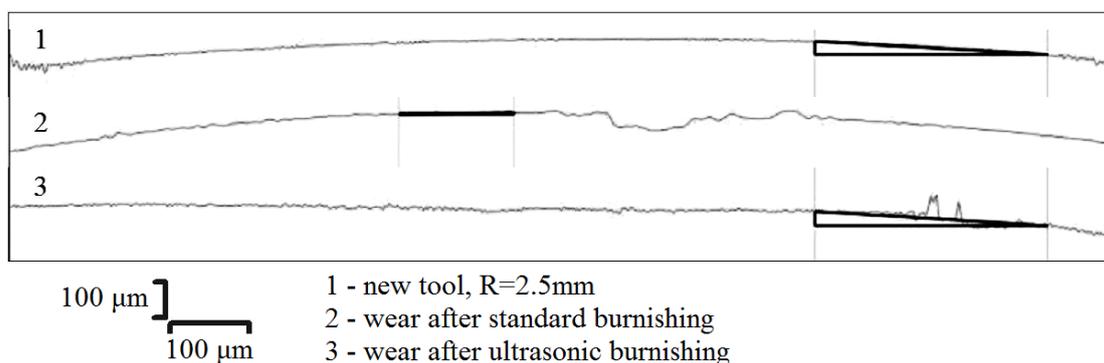
Identification of the burnishing state of tools after the standard and ultrasonic burnishing was carried out by optical microscopy on a metallurgical microscope "Labomet" with a maximum X800 magnification and using laser scanning microscopy on a Lext microscope (Japan) (figure 1).



**Figure 1.** Burnishing tools (a) and a picture of the tool surface with maximum magnification X800.

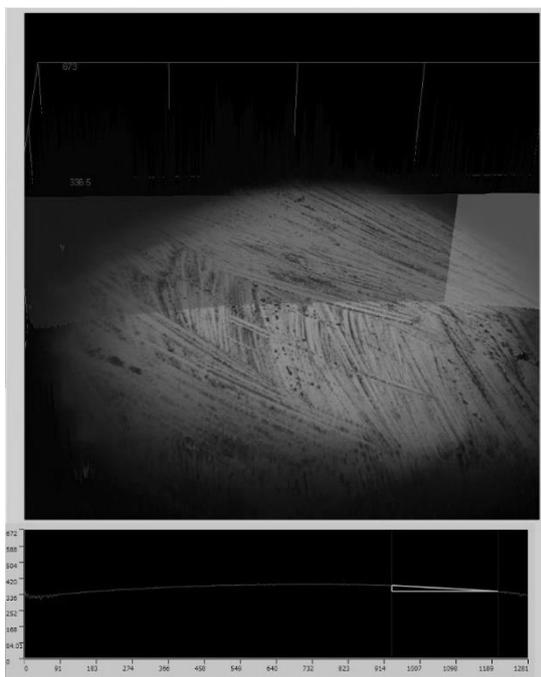
It was found that with ultrasonic processing, along with tool wear, there are such failures as plastic deformation of the tool, destruction of the solder and loss of the working part, and destruction of the threaded connection in the ultrasonic concentrator. Statistical analysis of tool failures in various modes of ultrasonic processing revealed that 80-90% of the instrument failure is a working part's wear, 5% - destruction of the solder and loss of the working part and 10% is associated with the destruction of the threaded section of the adapter.

In the case of ultrasonic burnishing, the tool has considerable dynamic loads, and the shape of the source of its wear has a specific shape (figure 2). This requires taking into account the macrostructure of the topography of the tool wear area [8, 9].



**Figure 2.** Comparison of the new tool's surface and surface after burnishing with ultrasonic processing.

As follows from the analysis of microscopic studies, in the standard processing as a result of friction, there is initially developing system of microdeformation folds of material oriented perpendicular to the direction of the velocity vector. With further operation of the tool, microcracks develop to critical dimensions, combine with each other, and a part of the material is segregated, i.e. its wear. The most developed section of the wear of the burnishing tool is displaced relative to the center of the tool axis to the area where the maximum loads are applied during processing. Principal differences in the development of wear's centers are observed with ultrasonic burnishing. In the process of ultrasonic treatment, the tool provide an impact effect on the material being processed in a practically perpendicular direction. As a result, the tangential friction force is minimal and in the issue of such a multifrequency impact load, the probability of the tool failure will be predominantly microscopic (figure 3).



**Figure 3.** Microscales on the tool's surface after ultrasonic processing.

As can be seen from the photographs, the wear center of the tool's working area after ultrasonic processing is a set of micro-craters of destruction caused by brittle impact fracture. And the size of the craters is almost the same. It can be assumed that this kind of development of wear centers during ultrasonic processing is caused by cavitation of the lubricoolant layer or oil films remaining on the part's surface.

In assessing the application of the obtained results, it is necessary to take into account that other machining processes, such as grinding [10-13] have a different mechanics of tool wear and a thermal image [8-9]. The presence of coatings [14-21] also introduces further adjustments to the nature of wear. It is also necessary to take into account the different mechanism of contact for other technologies of surface plastic deformation (SPD) [22-25].

### 3. Conclusion

Thus, it is appropriate to use more impact-resistant materials to manufacture the instrument used for ultrasonic processing.

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